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Green Energy and Green Buildings in Egypt

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ABSTRACT

This paper addresses the current status and the potentials of energy efficiency and renewable energy applications in Egypt. The use of primary energy resources had increased while the primary energy demand and GDP had decreases in the last two years. Egypt economy uses more than 50% of final energy per GDP than other surrounding counties. Egypt has adopted various sets of measures that increase the role of renewable energy sources for supplying and substituting fossil energy. Egypt had started several projects which focus wind farm in the Suez Gulf Zone with high wind speeds which ranges between 8 – 10 m/s in average and also due to the availability of large un-inhabitant desert area. Over 60% of the total electricity consumption is attributed to residential, commercial and Governmental buildings. To improve the energy efficiency of buildings, three building energy codes were published for new residential [1], commercial [2]and Governmental [3] buildings. These codes estimate to improve the efficiency by about 20% of total Electricity consumed.

I. Introduction

A significant increase in electricity demand is expected over the next few years with a growth rate of 6.8%. The primary energy supply in Egypt increased from 67.2 million tons of oil equivalent (M.toe) in 2007 to 89.2 M.toe in 2012. During the same period, the Gross Domestic Product (**GDP**) increased at an average rate of 7.2%, but decreased to 1.8% in 2012. As a result, the energy intensity of Egypt's economy increased by 9%. Buildings consume about 52% of the total electricity production; renewable energy not yet takes the positive roll in the energy demand. In April 2008, the Supreme Council of Energy in Egypt has adopted a resolution, on an ambitious plan to increase the share of Renewable resources in the total generated electricity to reach 20% by the year 2020. In ◌August 2009, the Egyptian Supreme Council of Energy had formulated a New Energy Efficiency Unit under supervision of the Ministry Cabinet to advice and proposed the procedure to reduce the energy consumption by 5% in 2010 relative to year 2009. In addition, a New Supreme Council of Green Buildings was established in 2009 to develop a New Green Building Code for New Urban Communities. The draft of the Green Pyramid Rating System (GPRS) recently developed [4]. The Supreme Energy Council of Energy which represents the Technical Cabinet of Ministers in Egypt supports efforts to increase the potential of Energy Efficiency use and encouragement new projects to add Renewable Energy Technology particularly wind, solar and increase the efficiency of hydro-energy. The potential of Renewable Energy in 2020 is estimated to be 20% of the total Energy uses in Egypt mainly wind and hydropower. The primary focus has been on industrial sector, and residential and street lighting, while some studies on other end use sectors have been carried out in limited scale.

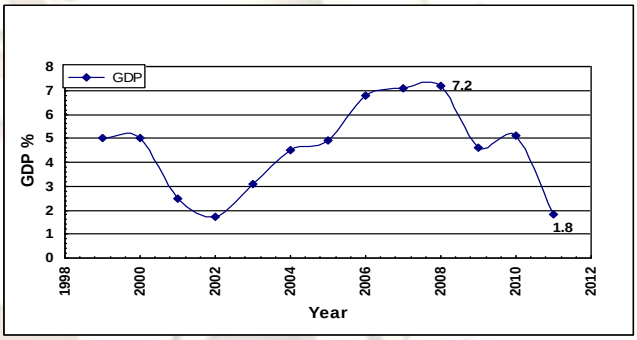

Fig. 1 GDP Real Growth Rate

The fast growth in energy supply has been accompanied by a fast growth in emission of air pollutants. Egypt's fossil fuel-related CO_2 emissions has closely followed energy growth, increasing from 84 million tons in 1995 to 169 million tons in 2007, making Egypt the 10th largest Greenhouse Gases (**GHGs**) emitter in the world. Under a business as usual scenario, it is projected that the primary energy supply will rise to more than 130 Mtoe in 2020. The Government of Egypt (**GOE**) has been busy increasing energy supply in order to meet the growing demand, while energy efficiency, particularly on the demand-side, has received less attention. It is believed that there is a substantial potential for energy efficiency improvements across various end use sectors that could be exploited in moderating the energy demand growth and reducing the energy infrastructure investment needs, as well as mitigating the environmental impact of energy production and use. In recent years, high and unstable energy prices and supply uncertainties have lead the Government of Egypt to give greater

considerations to energy efficiency. It is recognized that energy efficiency can help reduce the cost of energy services and enhance energy security and reliability in an environmentally sustainable manner. Consequently, **GOE** has started to promote the rational use of energy and to improve energy efficiency on the demand side. The primary focus has been on industrial sector, and residential and street lighting, while some studies on other end use sectors have been carried out in limited scale. The **GOE** is contemplating developing ambitious energy efficiency targets, establishing national agency, implementing market, regulatory and administrative tools, and setting up dedicated funding to promote energy efficiency programs. However, this general interest in energy efficiency is yet to be followed by putting into place a comprehensive policy framework and institutional structure to promote and implement energy efficiency programs.

II. Egypt Economy and Energy

The current national energy supply mix in Egypt is; 95% from fossil fuel; (petroleum products and natural gas); 5% from renewable resources (mainly hydro and limited wind). The electricity generation activity utilizes around 30% of the fossil fuel and natural gas resources in addition to all the hydro and wind energies resources. The industrial activities in Egypt consume around 20% of the overall all energy available. The average annual gross for energy (GDP) use was around 7.2% over the last decade and it is dropped to 1.8 during 2011/2012. A large number of studies, national and international, showed that it is quite possible to limit the increase in energy use without negative effects on the different production activities.

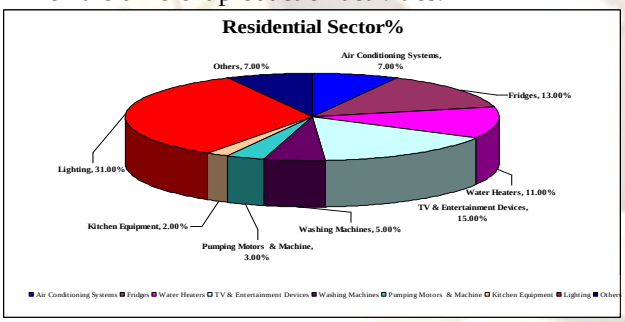

Fig. 2 Electricity consumed in residential sector by type

With over 52% of total energy consumed electricity represents the largest source of energy consumption followed by natural gas and LPG consumption. As highlighted, Lighting (31% of total electricity consumption), entertainment devices (15%) and fridges (13%) make up the largest components of residential electricity consumption, as shown in Fig.2 [5].

III. Energy Efficiency in Egypt

Egypt depends on fossil fuels (**95%**) such as oil (**39.3%**) and natural gas (**55.2%**) to meet the demand of Energy showing an increasing trend coupled with negative prospects for economic development, increasing population, and increasing energy consuming. The trend of the last decade shows a strong substation of oil by natural Gas. Fig. (1) shows the electricity consumption in 2011/2012. The increase in the overall energy demands has reached to 125159 GWh, where the main consumers are buildings users. The residential buildings take 41.1%, commercial by 8.2% and Governmental buildings 4.9%. The number of residential apartments in Egypt is approximately 20 million while the mixed use apartments are about 6 million. The residential sector consumes about 51 TWh electricity and 7 Mtoe energy. The number of commercial and public buildings is nearly 1617217 and 196308, respectively. These buildings consume about 3 TWh and 16 TWh, electricity. Artificial lighting and hot water systems are highest electricity consuming.

The Ministry of Electricity and Energy (**MoEE**) has approved initiatives to increase significantly the use of efficient light bulbs and street lighting. A program to disseminate up to 11 million compact [6] fluorescent Lamps (**CFL**) was carried out by the electricity distribution companies.
The Egyptian Ministry of State for Environmental Affairs started an energy efficient and environmental program by replacing the old taxis by New Compressed Natural Gas (**CNG**) driven cars. The Government also decided to convert the official cars to **CNG**. The Government of Egypt started a National program to convert the Tourist City of Sharm El-Sheikh into Green City.

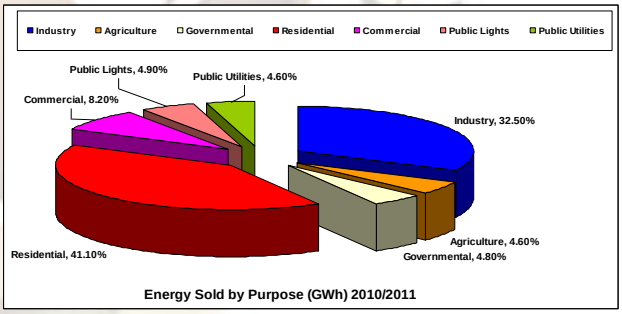

Fig.3 Electricity Consumption 2010/2011

With over 50% of total energy consumed electricity represents the largest source of energy consumption followed by natural gas and LPG consumption. As highlighted, Lighting (31% of total electricity consumption), entertainment devices (15%) and fridges (13%) make up the largest components of residential electricity consumption.
A pilot field and visibility case study was carried out [6] to investigate and evaluate the lighting improvements in the Ministry of Water Resources and Irrigation's Office Complex in Cairo, Egypt.

This project was sponsored the UNDP/W aimed at developing a replicable model for procuring energy efficiency measures in public buildings. The concept was to reduce the burden on the Government budget by shifting a big part of the investment to an Energy Service Company and to achieve increased performance reliability at competitive prices. An energy saving was achieved between 32% and 76% depending on the type of lighting fixtures and measure. The **GOE** was approved to repeat this study on 25 Governmental Building to be applied on all Governmental and Office buildings in Egypt.

New Green Village (**PLAV**) was approved and developed and will be constructed at El Fayoum Governorate to residence about 15000 inhabitants. The new green village will designed with deferent green building design adopted from different Asian countries with similar cultured and climatic conditions. These buildings will under field investigation to adopt the suitable design to be applied for most the Egyptian lands.

IV. Renewable Energy Sources

In April 2007, the Supreme Council of Energy of Egypt has adopted a resolution, on an ambitious plan to increase the share of the Renewable resources in the total electricity to reach 20% by the year 2020. At present almost all energy carriers in Egypt are subsidized. On the other hand, low energy prices have led the country to overusing scarce energy resources, and the primary energy intensity, the relation between primary energy demand and GDP, has been decreased in the last year to 1.8%.

Egypt was among the first nations to use renewable energy resources, especially in solar architectural, crops dehydration, pumping and in using animals and agricultural wastes. The Egyptian renewable energy strategy aims to generate 3% of the total electricity demand using renewable energy by 2010. The estimated energy saving in some household and industrial applications is 90000 TOE, and 60000 TOE from electricity generation using wind farms, in addition to 3.6 million TOE biomass. A new and renewable energy resource includes solar, wind and biomass. The energy utilization from such resources was estimated to be 150,000 TOE in 2003 in addition to 3.6 million TOE biomass.

4.1 Hydropower

Most of the available hydropower energy resources in Egypt were exploited with construction of the Aswan reservoir, high Dam, the Esna hydropower station, and Nagah Hamady with installed capacity of 550 MW 90 MW and 5 MW respectively. There are some other hydropower potential resources at Nagah Hamady and Assiut , as well as some other small available capacities at main canals of the river Nile ,in the Delta ,and at the Zefta barrages on the Damietta Branch of the Nile . A feasibility study for constructing a peak load hydropower station (pump and store) at Attaka and El-Gallala on the Red Sea is now being made.

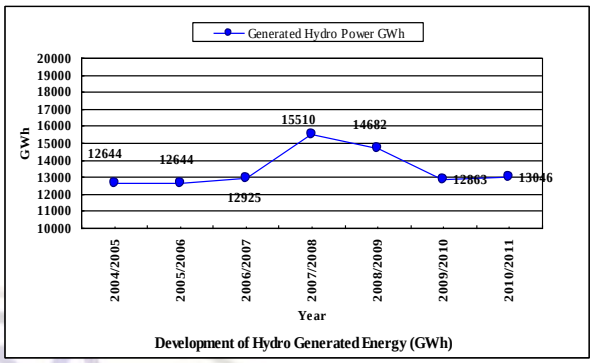

FIG.4 Development of Hydropower generated

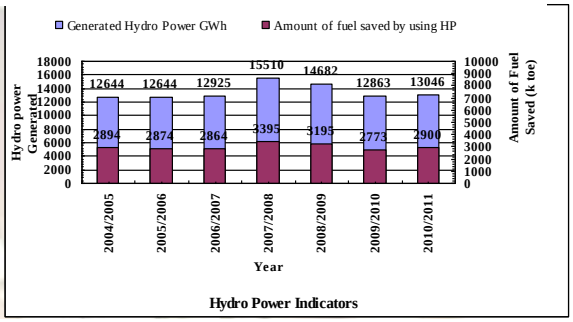

Fig.5 Fuel Saved due to the use of Hydropower.

4.2 Solar Energy

Egypt lies between latitudes 22 and 32 with a daily 9 to 11 hours of sunshine. Solar energy is available in all regions with an average total solar radiation 1900-2600 kWh/m^2/year, while the direct solar radiation is 1970-3200 kWh/m^2/year.

The first thermal power plant is constructed at El-Kuraymat, 50 Km south west of Cairo. The Installed capacity is 140 MW out of which 20 MW is the capacity of solar component and using hybrid solar, combined cycle (**CC**) before introducing the steam turbine (**ST**) to generate electricity.

The power Plant is financed from the Global Environmental Facility (**GEF**) and Japan Bank (**JICA**) for International Development.

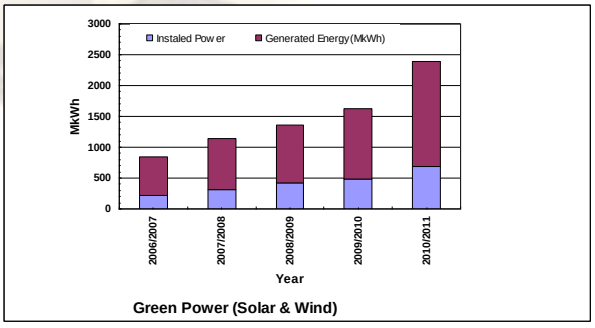

Fig. 6 Development of wind and solar Energy.

estimated total energy generated of 852 GWh/year. The new station will save about 10 thousand tones TOE and reduce the CO_2 emission by 20 thousand tones/year. Two concentrated solar power plants,

with total capacity of 100 MW at Kom Ombo, south of Egypt and four photovoltaic plants with total capacity of 20 MW will be operated during the five year plan 2012-2017.

4.3 Wind Energy

Egypt is endowed with an abundance of wind energy resources especially in Suez Gulf area which considered one of the best sites in the world due to high and stable wind speeds. The West of Suez Gulf is the most promising sites selected to construct the largest wind farms in the Middle East and Africa. The wind speed ranges from 8-10 m/s in average, see table (1), and also due the arability of large inhabitant desert area. Egypt enjoys considerable wind energy resources, with an average wind speed of 10 m/s in Gulf of Suez area and 7 m/s in east Owainat area and Zafrana region with about 9.5m/s. A wind atlas [9] has been issued for gulf of Suez region. Currently a wind atlas for Egypt is being developed. A pilot wind farm was built at hourghada; consist of 42 wind unit (100-300 KW each) with 5.4 MW capacities. Its output has been connected to local electricity grid since 1993.
EEHC/EETC and NREA cooperates to achieve the ambitious targets of the country strategy to reach 20% of the energy generated by year 2020 from renewable projects (Hydro, Wind and Solar). In 2001, GOE encourage private sector to build own and operate (BOO) wind power plants in Egypt. have been executed in year 2001. The estimated electrical energy production is more than 570 TWh/year. The energy saving will be more than 125,000 TOE/year. Tow successive stages of wind farm at Zafrana (140MW). The target for total installed capacity of wind energy is about 650 MW by year 2010. A new project was started at Gabal El-Zeit in the Suez Governorate to establish a new wind farm to produce 220 MW. This project was covered by long term loan from Japan Government by 430 MUSD. According to the Wind Atlas in Egypt published by NAREA in cooperation with the National Laboratory RESO resources have been identified

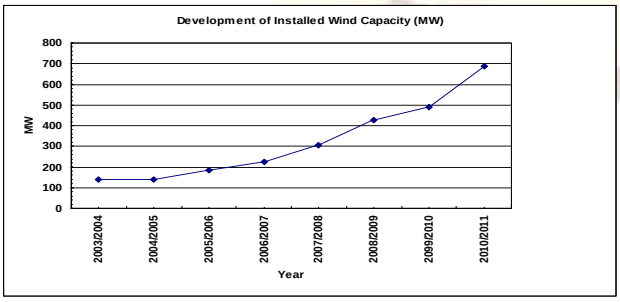

Fig.7 Development of Wind Energy (Zafrana)

he height of 50 m above ground level is between 400 and 800 W/m²- wind speed (> 9 m/s) ' Western Egypt Domain at the west bank of the Nile-Class 1 at the height of 50 m above ground level is between 300 and 400 W/m² - wind speed (7-8 m/s)' Areas close to Kharga -Class 1 at the height of 50 m above ground level is between 300 and 400 W/m² -with wind speed (7-8 m/s); Eastern Egypt domain at the east bank of the Nile-Class 1 at the height of 50 m above ground level is approx. 300 W/m² -wind speed (6-7 m/s);

Table 1 Wind Data for promising areas in Egypt

Region/station	U(mean Wind speed) m/s	E (mean power density)W/m^2	DU Direction deg
North West Coast			
Sidi Barrani	6.2	254	324
Alexandria	4.6	99	329
North Coast			
EL Arish	2.8	37	303
Gulf of Suez			
Hourghada	6.7	308	322
Kosseir	5.64	187	321
West Desert			
Kharga	6.6	268	345
Aswan	4.8	102	346
Shark El-Ouinat	6.5	222	355

Gulf of Aqaba area Class 1 at the height of 50 m above ground level is between 400 and 600 W/m². (National reserve so restricted site). Most of the sites where high wind speed exists fill into state own lands. Additional 1.5 million feddans (=6300 m^2) of state-owned lands in the Governorates of Beni Suef, Menya and Assiut are earmarked for wind generation projects.

4.4 Biomass

Production of biomass energy using agriculture, animal, human, and solid wastes has high potential in Egypt. Power generation from the gasification of sewage sludge in waste water treatment plants (EL-Gabal El-Asfer 23 MW plant) is already been used. High potentials projects for power generation based on gasification or direct combustion of organic solid wastes or agricultural wastes are under considerations. A potential of 1000 MW could be generated from agriculture waste.

4.5 Air and Water Pollution and Energy

Two main factors increase the air pollution in great Cairo Egypt, namely; cars, trucks and industry. Cars and trucks contaminates the outdoor environment by about 30% depends on the number of cars, street width, building height and town planning. Industry is responsible by another 30% while agriculture and garbage burning are 6% and 3%, respectively. Egypt's fossil fuel-related CO_2 emissions closely followed energy growth, making

Egypt the 10th largest greenhouse Gases (**GHGs**) emitters in the world.

V. Egyptian Energy Efficiency Programs

Energy conservation programs are applied according to the purpose of consumption. Lighting accounts 23% of the total energy sold in Egypt. Reducing the consumption of street lighting by 50%.

1. Use of CFLs and electronic ballasts.
2. Use of high efficient household electrical appliances.
3. Rational use of electricity such as; natural lighting,
   shut off light in unoccupied spaces, adjust AC at 25°C and cleaning the AC filters.
4. High efficient street lighting (CFLs 85, 120 watt) and
   high pressure efficient sodium lamps (100-150 watt)
   are implemented.
5. Decrease the electricity subsidies 10% to 20% for different segments. Energy subsidies is about 114
   Billion Egyptian Ponds, which represents about 22%
   From the total governmental subsidy in all sectors in
   Egypt, see Fig. (8).

VI. Conclusion

This paper presents the potential of Energy Efficiency and Renewable Energy sources in Egypt. The main conclusions derived from this paper may be summarized as follows:

- Hydro power from the high dam and other stations contributes about 9% of the total power.

Wind Energy is very promising and needs more chair from the private sector.

- Solar Energy not received much attention, since the electricity is subsidies and much must given to SWH for domestic use by incentive and rebate, and banking financial cover for the initial coast.
- As long as all petroleum products and natural gas are priced far below value, no level playing field for RE (RE appear too costly) in power generation and decentralized application.

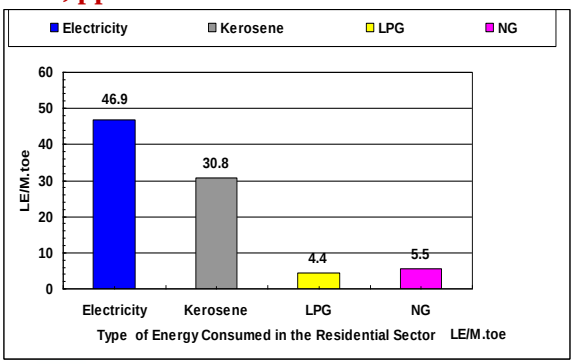

Fig. 8 Energy subsidy for residential and commercial buildings sector for year 2010/2011

- The way out to change the instruments; restrict low energy prices to basic energy (and public transportation), and increase the incentives for efficiency and the disincentives for misappropriation, smuggling, and wasteful consumption.
- Egypt decided to reduce the VAT for renewable energy Equipment.

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